

REMARKS

A Request for Continued Examination was filed in this application on September 27, 2004 with an Amendment. The Amendment was identified as nonresponsive in a communication mailed from the U.S. Patent and Trademark Office on October 27, 2004 as having amended the claims to embrace an "invention that is independent or distinct from the invention originally claimed." This Amendment accordingly presents claims for examination drawn to the original invention as identified in that communication by deleting the language related to deposition of a second uppercladding layer with PECVD. A divisional application is being filed separately to prosecute the claims presented in the prior Amendment.

Pursuant to the Office Action mailed July 26, 2004, Claims 1 – 7, 13 – 15, 18, 20, 23, and 24 stand rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Pat. No. 6,154,582 ("Bazylenko") in view of U.S. Pat. No. 6,080,683¹ ("Faur"), U.S. Pat. No. 6,122,934 ("Narita"), and U.S. Pat. No. 6,204,200 ("Shieh"), and optionally in view of U.S. Pat. No. 6,705,124 ("Zhong"). Each of the remaining claims stands rejected under 35 U.S.C. §103(a) over such cited art further in view of other references identified in the Office Action.

In addition to amending the claims to be clearly drawn to Species A identified in the September 27 communication, independent Claim 1 been amended to clarify certain aspects of the invention. In particular, it has been amended to clarify: (1) that the high-density plasma process used to deposit the uppercladding layer includes simultaneous deposition and sputtering components (*see* Application, p. 20, ll. 4 – 5); and (2) that the gaps defined by the plurality of optical cores have a width between 1 and 2 μm and an aspect ratio between 2:1 and 7:1 (*see* U.S. Pat. Appl. No. 10/020,461, which has been incorporated by reference (*see* Application, p. 17, ll. 25 – 29) at p. 9, ll. 9 – 11 disclosing cores with height 4.5 – 7.2 μm separated by widths of 1 – 2 μm). These amendments clarify the physical nature of the high-density plasma deposition process used for deposition of the uppercladding layer and quantify the scale of the deposition process.

Applicants have previously noted that the scale is highly pertinent in assessing the relevance of the teachings of different references. In particular, absent a specific teaching to do

so, one of skill in the art would not be motivated to consult references directed to gapfill at one scale in addressing an issue concerning gapfill at another scale differing by as much as an order of magnitude. Thus, while applicants acknowledge that the prior art teaches gapfill with silicon dioxide in both electronic-device and optical device contexts, they disagree that one of skill art would view specific process parameters identified as suitable for one such art at one scale to be relevant to the other at a different scale. The physical processes involved in gapfill are well known to depend not only on the shape of a gap as defined by its aspect ratio, but on the absolute size of the gap. That is, material is deposited very differently in a gap having a width of about 0.1 μm and a depth of about 0.5 μm as compared with a gap having a width of about 1.0 μm and a depth of about 5.0 μm when the same process is used; this is because the physical mechanism by which the gap is filled is different even though both gaps have an aspect ratio of about 5:1. The gapfill mechanism results from a complex interplay of parameters that affect differently sized structures differently — the gapfill mechanism is affected by quantities that are determined by the process parameters, such as ionic-species density, ion kinetic energy, and the like. Applicants raise this issue of relative size not to argue that a change in size leads to a patentable invention, but to note that the physics that governs gapfill deposition at different scales is different, and that the teachings of the prior art are accordingly limited in application.

For example, the Office Action argues that the difference in feature sizes between Bazylenko and Rossman *increases* the motivation to combine their teachings (Office Action, p. 9). The argument is that Rossman's teaching of increasing the deposition rate would advantageously result in a greater decrease in deposition time at the larger optical-device scales than it would at electronic-device scales. But Rossman teaches specifically that such an increase in deposition rate be coupled with an increase in the simultaneous etching rate provided by an HDP process (Rossman, Col. 2, ll. 54 – 57: "This is accomplished by rapidly increasing the etch rate of the dielectric layer, which allows increasing the deposition rate while maintaining a suitable dep-etch ratio"). Because both the deposition and etch rates are increased, it is not apparent that the overall deposition time is reduced. Rather, the manner in which the plasma interacts with the gap structure is being altered to take advantage of physical processes that improve void-free gapfill in the complex relationship among ionic density, particle kinetic

¹ There appears to be a typographical error in the Detailed Action.

energy, and the like, factors that have been noted as affecting the process differently depending on the size of the structure. It is not apparent that a larger structure, even one of the same shape, would benefit from the same approach because the effect of a high plasma density in a small structure provides a different physical mechanism for gapfill than it does in a larger structure.²

Thus, in considering the claims in light of the cited art, Applicants note that the optical core described in Bazylenko has a thickness of about 4.5 μm (Bazylenko, Col. 6, l. 65). Bazylenko does not disclose the recited features of the gaps, namely their aspect ratios and widths, because there is no disclosure of a plurality of cores. The Office Action cites no art teaching or suggesting a modification of Bazylenko to provide a plurality of cores, offering as motivation only the observation that “it would have been obvious to put multiple cores on the substrate so as to have more pathways for light communication” (Office Action, p. 2). But there is nothing in Bazylenko to suggest the desirability of more light-communication pathways and it is not at all apparent how the structure would be arranged to provide such pathways. In

² In this context, Applicants note as follows how the deposition-sputter ratio of Rossman was determined in a previous Office Action. Rossman characterizes the relative contributions of deposition and sputtering arising from the HDP process in terms of a “deposition-etch” ratio defined as:

$$D/E \equiv \frac{D_S}{D_S - D_{(S+B)}},$$

where D_S is the deposition rate with only the RF source applied and $D_{(S+B)}$ is the deposition rate with both the RF source and RF bias applied (Rossman, Col. 12, ll. 42 – 52). Rossman teaches that the D/E ratio be within the range of 2.8:1 to 3.2:1 (*id.*, Col. 12, l. 56). The application characterizes the relative contributions of deposition and sputtering in terms of a “deposition-sputter” ratio defined as:

$$D/S \equiv \frac{(\text{net deposition rate}) + (\text{blanket sputtering rate})}{(\text{blanket sputtering rate})},$$

with the “net deposition rate” referring to the deposition rate measured when sputtering and deposition occur simultaneously and the “blanket sputtering rate” referring to the sputter rate when the recipe is run without deposition gases (Application, p. 20, ll. 4 – 12). The quantities used in each definition are not easily related, but the D/S value may be expressed approximately as

$$D/S \approx \frac{D_S + D_{(S+B)}}{D_{(S+B)}},$$

with the definition of D/E providing that $D_{(S+B)} = D_S - \frac{D_S}{D/E}$. Substitution of this gives the approximate relationship that

$$D/S \approx \frac{2 - (D/E)^{-1}}{1 - (D/E)^{-1}},$$

so that the range of D/E of 2.8 – 3.2 corresponds approximately to a range of D/S of 2.4 – 2.6.

particular, the optical core in Bazylenko is intended to couple light from an optical arrangement (such as an optical fiber connected to an optical system) into an electro-optical transducer to provide an electrical signal to an external circuit or device (Bazylenko, Col. 4, l. 66 – Col. 5, l. 18). There is nothing in Bazylenko to suggest that additional pathways between the optical arrangement and electro-optical transducer are desirable, and the Office Action identifies no purpose for such additional pathways. The disclosure of Bazylenko on its face appears to indicate that the objective of coupling light between the optical arrangement and electro-optical transducer is fully achieved with the structure of the optical core as described. Furthermore, it is not apparent that additional optical cores provided to increase the number of pathways between the optical arrangement and the electro-optical transducer would be arranged geometrically to provide a well-defined width and aspect ratio of gaps between cores.

In addition, Bazylenko includes no disclosure of using a deposition process for the uppercladding layer that has simultaneous deposition and sputtering components. While specific details are provided for the deposition of the electro-optical transducer and the optical core, Bazylenko only tersely notes that “[t]he final structure is then capped with an appropriate waveguide cladding layer (using PECVD)” (Bazylenko, Col. 9, ll. 37 – 39), without disclosing the use of a process with simultaneous deposition and sputtering components for that deposition.

The Office Action also cites Rossman as standing for the proposition that multiple optical cores is conventional. But Rossman is not directed to optical applications and is instead directed to gapfill between “conductive features” (Rossman, Col. 1, ll. 22 – 42), citing a scale that provides gap widths of about 0.18 μm (Rossman, Col. 1, ll. 13 – 22). While a patterning of conductive features used in electronic applications to provide gaps that need to be electrically insulated may be conventional, nothing in Rossman teaches or suggests a similar patterning in optical applications.

Shieh is cited as demonstrating that the deposition/sputter ratio is a result-effective variable and for disclosing values of that ratio consistent with those claimed. But Shieh is also directed at electronic applications requiring gapfill between “metal lines” that need to be electrically insulated (Shieh, Col. 2, ll. 55 – 65). The specifically disclosed values that achieve such deposition are for scales where the gaps are about 0.3 μm , and are therefore not believed to be relevant at the very different physical scales now recited explicitly in the claims. It is also

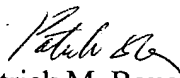
respectfully noted that the inquiry of whether it would be a matter of routine experimentation to optimize the deposition/sputter ratio is relevant only after establishing that the claims are otherwise "encompassed by the prior art" (MPEP 2144.05). Since the cited art does not establish that the combination of claim limitations was otherwise known and encompassed the recited range for the deposition/sputter ratio, the inquiry should not be reached.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 303-571-4000.

Respectfully submitted,


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